

PATENT APPLICATION

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Title of Invention:

Terminal Alignment Features For Bulb Sockets

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TERMINAL ALIGNMENT FEATURES FOR BULB SOCKETS

CROSS-REFERENCE TO RELATED APPLICATIONS

5 This application is a continuation-in-part of U.S. Patent Application 10/264,221, filed October 3, 2003, which claims the benefit of U.S. Provisional Application No. 60/326,936, filed October 4, 2001.

FIELD OF INVENTION

10 The subject disclosure relates generally to automotive exterior lighting. Specifically, it relates to light bulb sockets and terminals that are used in automotive lamp assemblies.

BACKGROUND

15 Automotive lamps generally employ light bulbs as their light source. These bulbs connect to the rest of the lamp assembly and receive their electrical power through lamp bulb sockets in the lamps. The design of these lamp bulb sockets vary but must at their most basic form contain means to secure the bulb in place in the socket, means to provide the bulb with the electrical power to function, and means to secure the lamp socket to the rest of the lamp assembly. While these are the minimum requirements for a lamp bulb socket, there are numerous other design characteristics that are desirable in modern lamp bulb sockets.

20 Lamp bulb sockets are typically one of two types. First, "axial" lamp bulb sockets include a housing body that extends directly behind the lamp. The housing body directs the wires connected to the lamp bulb socket away from the lamp bulb socket. In this manner, the wires are placed directly behind the lamp bulb socket and run parallel with an insertion axes 190 (See Figure 1) along which the lamp bulb is inserted into the lamp bulb socket. Second, "right
25 angle" lamp bulb sockets include a housing body that extends behind the lamp and then at a right angle away from the lamp. The "right angle" housing directs the wires connected to the lamp bulb socket away from the lamp bulb socket at a right angle to insertion axis 190.

The "axial" lamp bulb socket has the disadvantage of taking up a lot of space directly behind an automotive lamp, because the wires, terminals and the seals of the wires to the terminals all take up a great deal of space. A socket that takes up a lot of space directly behind an automotive lamp is undesirable because it limits design options for manufactures and prevents lamp sizes from being further reduced. In contrast, "right angle" lamp bulb sockets do not take up as much space directly behind an automotive lamp because they direct the wires at a ninety degree angle away from the lamp. However, while the right angle socket decreases the need for space directly behind the lamp socket, it increases the diameter space needed around the lamp to house the right angle socket. This too limits design options for automotive manufacturers. These limitations could be avoided with an automotive lamp bulb socket that occupies the same amount of space as a right angle socket directly behind the lamp but at the same time occupies the same amount of diameter space as an axial lamp socket around the lamp.

Another disadvantage with current lamp sockets is that they are manufactured with exteriors that permit either "axial" or "right angle" loading of the lamp bulb socket into the lamp assembly, but not both. As a result, two types of sockets must be produced by suppliers. This creates additional manufacturing expenses. These expenses could be eliminated or minimized by the use of a lamp bulb socket which is designed with an exterior that permits the same socket to be loaded either axially or at a right angle during lamp assembly. Such versatility in the exterior shape of the lamp bulb socket is just one of a number of desirable exterior design characteristics of lamp bulb sockets.

There are a number of additional qualities which are desirable on the exterior of a lamp bulb socket. First, the lamp bulb socket should be designed with exterior features which allow the socket to be easily aligned with the rest of the lamp assembly. This simplifies the process of attaching the lamp bulb socket to the lamp assembly and reduces manufacturing costs. Second, the exterior of the lamp bulb socket should contain a mechanism to securely lock the socket to the rest of the lamp assembly. This prevents the bulb socket from becoming loose inside the lamp assembly which could lead to the malfunction of the light source and the loss of

illumination. Third, it is desirable for the exterior of the lamp bulb socket to contain a mechanism to prevent the over-rotation of the lamp bulb socket as it is being attached to the lamp assembly.

There are also qualities which would be desirable in the wiring of the lamp bulb socket.

5 First, the lamp bulb socket should be designed to eliminate the pinching or misalignment of wires during the insertion of a light bulb into the socket. The pinching or misalignment of wires could prevent the proper connection of the bulb with the electrical terminals in the socket leading to a faulty electrical connection. The result is an inoperable light source. Second, the lamp bulb socket should be wired to eliminate as much wire splicing as possible. The elimination of wire
10 splicing is desirable because it decreases the cost of manufacturing by reducing the number of necessary splicing operations, subsequent splice sealing operations, and components needed in constructing an automotive lighting system. Third, the electrical wiring used should be connected to the terminals of the lamp bulb socket by the most efficient method possible. It is also desirable that this connection be environmentally sealed to prevent the elements from
15 degrading the connection and contributing to a premature failure of the light source. An environmental seal located between the lamp bulb socket and the lamp assembly is also required. This seal should be designed to minimize the force required for its installation in order to reduce the cost of manufacture.

In addition to the aforementioned desirable exterior qualities of a lamp bulb socket, the
20 interior of the socket should also be designed with a number of beneficial qualities in mind. For example, the interior of the lamp bulb socket should be designed to help guide the lamp bulb into place. This is desirable for many reasons. First, properly guiding the bulb helps to prevent damage to the bulb's base during the installation of the bulb into the socket. Second, a design which guides the bulb into the proper position decreases the amount of force necessary for the
25 insertion of the bulb, thus, decreasing the cost of manufacturing. Third, properly guiding the bulb into place decreases the possibility of terminal or lead wire damage.

Similarly, the interior of the lamp bulb socket and the terminal assembly should be designed to help guide the terminal assembly into place in order to promote the proper positioning and alignment of the terminal assembly in the lamp bulb socket. The design of the terminal should be one that minimizes the amount of force necessary for the insertion of the terminal assembly into the bulb socket in order to decrease the cost of manufacturing. Further, the design of the terminal should be one that promotes dimensional control of the points of contact between the terminal assembly and the bulb socket so that the terminal is easily inserted into the bulb socket and then held firmly in place so that the terminals do not wobble back and forth and cause a faulty electrical connection. It is important that the terminals are properly aligned and stabilized in the bulb socket so that a proper connection is formed and maintained with the bulb.

Another design quality that is desirable in lamp bulb sockets is the ability to accept bulbs of varying size. This gives the manufacturer flexibility in the manufacturing process. However, one resulting problem of using differing bulb sizes is the tendency for smaller bulbs to rock or wobble in the lamp bulb socket. Lamp bulb sockets should be designed to incorporate means to eliminate or minimize this wobbling. In addition to means for minimizing the wobbling of the bulb, another desirable feature of lamp bulb sockets is for the bulb to be firmly held in place once the bulb is inserted. The bulb must be secured such that the bulb will not disengage from the lamp bulb socket. If the bulb was not firmly held in place, the proper electrical connection may be lost resulting in a loss of illumination from the light source. Finally, steps should be taken to reduce the mass of the entire lamp bulb socket. Any reduction in the mass of the socket reduces the cost of shipping the final assembled sockets.

Currently, manufacturers produce a number of types of lamp bulb sockets. No design has successfully embodied the above-discussed beneficial qualities. For example, many current sockets continue to have exterior designs which permit only "axial" or "right angle" loading of the lamp bulb socket into the lamp assembly. Additionally, many sockets employ two-piece terminals which require assembly in the socket. By requiring additional assembly, these

two-piece terminals are more likely to be misassembled. Two-piece terminals are also more prone to intermittent continuity problems and additional voltage drop. Thus, a lamp bulb socket employing one-piece terminals would be beneficial.

5 The lamp bulb socket terminals are usually connected to the power supply by wires which are crimped to the terminals. The terminals are then secured to the body of the socket by a piece called a terminal position assurance. This method of securing terminals requires additional pieces, is time consuming, and requires additional labor. This also increases costs and the rate of faulty connection. Additionally, the crimp method of connecting the wires to the terminals fails to provide a good environmental seal around the connection. As a result, these connections are
10 subjected to the elements and corrode after time. Another disadvantage of most current lamp bulb socket designs is the use of a wiring configuration requiring multiple splices and several wire seals. This configuration adds unnecessarily to the assembly time required and the expense of manufacturing and adversely affects the quality of the harness.

The current methods of stabilizing the bulb known in the prior art are also unacceptable.
15 Rigid bulb support members cannot be used to control the wobble of smaller bulbs and still allow the use of larger bulbs. Further, a separate piece stabilization feature has the shortcomings of increasing part count, manufacturing cost, assembly effort, and the possibility of the component becoming lost. Therefore, it would be desirable to find a new method of stabilizing the bulb.

Thus, a need exists for a lamp bulb socket which provides all of the desirable features
20 discussed above and which solves the related problems discussed above while remaining relatively inexpensive and relatively simple to assemble.

SUMMARY OF THE INVENTION

25 The terminal alignment features for bulb sockets, as disclosed herein, deal with improvements to the design of lamp bulb sockets, and the components therein, that are used in automotive lamp assemblies. The overall design of the embodiments of the lamp bulb sockets incorporate an omni-style external design which allows the lamp bulb socket to be loaded into

the lamp assembly either "axially" or at a "right angle." Embodiments of the subject invention include lugs which employ locking mechanisms to lock the socket into place and stopping mechanisms to prevent over-rotation during installation. These embodiments further utilize one-piece, right angle terminals which are connected to the required harness wiring by the crimp method and then sealed by a direct potting method. The direct potting method effectuates an environmental seal around the connection, prevents the connection from corroding and failing, reduces the overall size of the socket assembly, and allows for the socket to be right angle loaded or axially loaded. Additionally, these embodiments allow for a plurality of sockets to be daisy chained to one another with the connections still being environmentally sealed. This wiring configuration produces cost savings by reducing the required number of splices.

In addition to all of these external refinements, these embodiments incorporate a number of internal design improvements. One embodiment utilizes a series of alignment features on the interior of the socket to ease the installation of the bulb and decrease the risk of damage to the bulb during installation. These features include side rail alignment channels, centrally located angular ribs, and an axial channel.

Another embodiment comprises a stabilization feature in the interior of the bulb socket that comprises four edge surfaces. These edges are properly spaced so that they allow varying bulb sizes employing either single or multiple filament designs to be used. In conjunction with the tension of the terminals, these edges are able to hold a variety of bulb sizes tightly in place and prevent the bulb from wobbling.

Any of these embodiments can also comprise a terminal that provides for proper alignment and simple insertion of the terminal in the bulb socket and superior terminal to bulb electrical and mechanical interface. The terminal comprises a bulb connecting blade and two opposed terminal surfaces that are integral with the bulb connecting blade. The terminal also has at least two alignment features positioned on each of these opposed terminal surfaces. The alignment features are positioned and located on the opposed surfaces of the terminal so that when the terminal is inserted into the bulb socket, each of the alignment features contacts one of

the two opposed interior walls of the receiver slot of the bulb socket that accepts the terminal. The contact between the walls of the receiver slot and position and location of the alignment features allows for simple insertion of the terminal into the bulb socket and stabilizes the terminal once it is inserted.

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BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a side view of an exemplary W-2 lamp bulb socket;

Figure 2 is a rear view of a lamp housing with a socket recess that can interact with the lamp bulb socket of Figure 1;

10 Figure 3a is a top view of a single ridge seal gasket used in the exemplary embodiment of Figure 1;

Figure 3b is a cross-sectional view of the single ridge seal gasket along line A-A of Figure 3a;

15 Figure 4a is an exploded, bottom view of the terminal accepting body of the exemplary lamp bulb socket of Figure 1 with two terminals;

Figure 4b shows an exploded, bottom view of the terminal accepting body of Figure 4a with another embodiment of the two terminals that include a plurality of terminal alignment features;

20 Figure 4c is a bottom view of the terminals accepting body of Figure 4b with the terminals inserted into the terminal accepting body;

Figure 4d shows a cross-sectional view of the lamp bulb socket along line E-E of Figure 4c;

Figure 5a is a perspective view of a one-piece, right-angle, wide terminal used in the exemplary lamp socket of Figure 1;

25 Figure 5b shows a perspective view of another embodiment of the terminal of Figure 5a that includes the terminal alignment features;

Figure 6a is a top perspective view of the bulb accepting body of the exemplary lamp bulb socket of Figure 1;

Figure 6b is a front view of a bulb used in the exemplary lamp socket of Figure 1;

Figure 6c is a side view of the bulb of Figure 6b;

5 Figure 7 is a top view of the bulb accepting portion in relation to the lamp bulb socket of Figure 1;

Figure 8 is a cross-sectional view of the bulb stabilizing feature along line B-B of Figure 7;

Figure 9 is a side view of an exemplary W-3 lamp bulb socket;

10 Figure 10 is a bottom view of the terminal accepting body of the exemplary lamp bulb socket of Figure 9;

Figure 11 is a cross-sectional view of the terminal accepting body along line C-C of Figure 9;

15 Figure 12 is a perspective view of a one-piece major/minor terminal used in the exemplary lamp bulb socket of Figure 9;

Figure 13 is a perspective view of a ground terminal used in the exemplary lamp bulb socket of Figure 9;

Figure 14 is a top view of the interior of the bulb accepting body of the exemplary lamp bulb socket of Figure 9;

20 Figure 15a is a cross-sectional view of the interior of the bulb accepting body along line D-D of Figure 14;

Figure 15b is a side view of a bulb used in the exemplary lamp bulb socket of Figure 9;

Figure 15c is a front view of the bulb of Figure 15b;

25 Figure 16 is a side view of the prior art method of electrically connecting a plurality of lamp bulb sockets together with harness wires spliced together; and

Figure 17 is a side view illustrating the wiring method of the subject invention where a single wire is daisy-chained between the individual lamp bulb sockets.

DESCRIPTION

The embodiments disclosed herein relate to an omni-style, wedge base lamp bulb socket assembly that allows for both "axial" and "right angle" loading of the lamp bulb socket into a lamp assembly. Two exemplary embodiments are described herein as the W-2 wedge base sealed lamp bulb socket assembly and the W-3 wedge base sealed lamp bulb socket assembly. In Figure 1, the W-2 embodiment is shown fully assembled comprising a bulb 10 and a lamp bulb socket 100. Lamp bulb socket 100 comprises a bulb accepting body 20 connected to a terminal accepting body 30, a plurality of wire retention slots 40, and three lugs 50 (only one pictured) molded onto the side of bulb accepting body 20, a seal gasket 70, and a seal flange 80. While the W-2 embodiment comprises three lugs 50, it will be appreciated by one skilled in the art that no lugs, a single lug or any number of a plurality of lugs can be used. Bulb accepting body 20 is preferably integral with terminal accepting body 30 and formed in a common mold. Terminal accepting body 30 includes an outer rim 31 where wire retention slots 40 are formed.

As further shown in Figure 1, an exemplary embodiment of lug 50 is molded with a stop feature 60 and a lock feature 90. While lug 50 is shown with stop feature 60, not all lugs need to contain the stop feature. The preferred embodiment of the socket 100 does provide for stop feature 60 on at least one lug 50 and, more preferably, at least two lugs will contain lock feature 90 and stop feature 60. In this embodiment, lock feature 90 can comprise a small projection, a bump, or a notch recess and stop feature 60 can comprise a short vertical wall. Stop features and lock features for socket assemblies are well known in the art. Thus, many equivalent types of lock features and stop features may be used to construct the disclosed embodiment.

As shown in Figure 2, a lamp housing 200 utilizes a socket recess 210 with three slots 220. Socket recess 210 is designed to accept W-2 lamp bulb socket 100 with slots 220 designed to interact with lugs 50. While this embodiment depicts socket recess 210 with three slots 220, it will be appreciated by one skilled in the art that socket recess 210 can comprise no slots, a single slot or any number of a plurality of slots, so long as the number of slots corresponds to the number of lugs 50 on socket 100. During installation, lamp bulb socket 100 is inserted into

socket recess 210, so that lugs 50 are inserted into slots 220 and seal flange 80 covers socket recess 210. Once inserted, lamp bulb socket 100 is rotated so that lock feature 90 slides over a protrusion (not shown) that is located on the side of the interior of socket recess 210 between slots 220. Once lock feature 90 slides over this protrusion, it is prevented from being slid back over the protrusion. In this manner, lock feature 90 interacts with the protrusion of socket recess 210 to provide a reverse rotation lock that retains lamp bulb socket 100 in its installed position. Further, lamp socket 100 is rotated until at least one stop feature 60 abuts against an edge of one of the slots 220. In this manner, stop feature 60 interacts with slot 220 to prevent lamp bulb socket 100 from being over-rotated during the assembly process.

Referring back to Figure 1, the W-2 exemplary embodiment further comprises a socket to housing seal gasket 70, which encircles lamp bulb socket 100. Figure 3a depicts a top view of an isolated seal gasket 70 and Figure 3b depicts a cross-sectional view of the seal gasket along line A-A of Figure 3a. As shown in Figure 3b, seal gasket 70 comprises a thick single ridge 110. In construction, seal gasket 70 is placed over bulb accepting body 20 of socket 100 and slid in between seal flange 80 and lugs 50, so that the seal gasket is kept in place by lugs 50 and by seal flange 80. Referring back to Figures 1 and 2, when socket 100 is installed into socket recess 210, seal gasket 70 is pinched in between seal flange 80 and lamp housing 200. In this manner, thick single ridge 110 compresses to create an environmental seal between lamp bulb socket 100 and lamp housing 200. The use of seal gasket 70 with a single ridge 110, instead of a seal gasket with multiple ridges, reduces the force necessary to install the seal gasket and decreases the percentage of seal compression. In this manner, seal 70 eases installation of socket 100 and reduces manufacturing costs of the socket assembly. While this embodiment utilizes a single ridge seal gasket 70 to ease installation, many equivalent types of seal gaskets may be used to construct the disclosed embodiment. For example, a seal gasket that utilizes two ribs or three ribs may be used.

Figure 4a displays an exploded bottom view of terminal accepting body 30 of lamp socket 100. As shown in Figure 4a, this embodiment further comprises two one-piece, right-

angle wide terminals 130, two right-angle terminal housing channels 140, two terminal blade receiver slots 150, and two harness wire retention slots 40. While the W-2 embodiment comprises two harness wire retention slots, it will be appreciated by one skilled in the art that any number of a plurality of retention slots or no retention slots can be used.

5 Figure 5a is a perspective view of right-angle terminal 130. As shown in Figure 5a, terminal 130 comprises a one-piece, right-angle wide terminal design that comprises a terminal lead end 132, a lamp bulb connecting blade 134, and a cover plate 136. While the preferred terminal 130 comprises a one-piece terminal design, it is realized by one skilled in the art that terminal 130 can comprise a two-piece terminal. The wide terminal design of terminals 130 is
10 advantageous because it makes insertion of the bulb easier and helps prevent harm to the bulb when it is inserted into socket 100. In this embodiment, cover plate 136 is located just above lamp bulb connecting blade 134 and the lamp bulb connecting blade is substantially perpendicular to the cover plate. This embodiment enables cover plate 136 to substantially cover the opening of receiver slot 150 when blade 134 is inserted into the receiver slot. Lead end 132
15 of the terminal 130 is aligned substantially perpendicular to the alignment of blade 134. Lead end 132 is substantially perpendicular to blade 134 because the axis along which wires 160 are inserted into the lead end is substantially perpendicular to the axis along which two prongs 137 of blade 134 extend. In contrast to an axial terminal, right-angle terminals 130 reduce the space needed to house socket 100 because terminal lead ends 132 are located closer to the terminal
20 accepting body 30 of the socket.

 Terminal lead end 132 comprises a wire cradle 139 and a wire connecting piece 138. An insulated harness wire 160 (shown in Figure 17) is laid into wire holding cradle 139 and connecting piece 138. The section of harness wire 160 laying in connecting piece 138 is stripped of insulation and is electrically connected to terminal 130 by crimping connecting piece 138 over
25 the wire. The section of harness wire 160 laying in cradle 139 remains insulated and is held in place by crimping the cradle over the wire. It is appreciated by those of ordinary skill in the art that terminal lead end 132 can comprise either a single crimp terminal lead end or a double crimp

terminal lead end. A single crimp terminal lead end 132 allows for one harness wire 160 to be connected to each terminal 130. A double crimp terminal lead end would increase the length of wire cradle 139 and wire connecting piece 138 to allow for two harness wires 160 to be connected to each terminal 130.

5 Lamp bulb connecting blade 134 comprises two prongs 137 and two substantially opposed terminal surfaces 44. In this embodiment, each of terminal surfaces 44 are integral with one of the two prongs 137. Prongs 137 are the same and each prong can either electrically connect terminal 130 to bulb 10 or serve to hold the lamp bulb in place in combination with a stabilizing feature 170. Terminals 130 may comprise many types of lamp bulb connecting
10 blades to connect the terminals to bulb 10 and is not limited to the blade 134 with two prongs 137 pictured in Figure 5a. For example, the blade could comprise a single prong.

 Figure 5b shows a perspective view of a second embodiment of the right angle terminal. As shown in Figure 5b, a right angle terminal 270 can further comprise alignment features 46. As used herein, the term "alignment feature" means any extension located on the terminal
15 surfaces of the lamp bulb connecting blade, that allows the terminal to be inserted into a bulb socket with reduced surface friction, such that the alignment feature is the primary point (aside from other alignment features) of the opposed terminal surfaces designed to contact the surface in the bulb socket during insertion. Referring to Figures 5a and 5b, terminals 130 and 270 each comprise the same components, except that terminal 270 has alignment features 46. Still
20 referring to Figures 5a and 5b, terminal 130/270 can further comprise a terminal side wall 135. In this embodiment, terminal side wall 135 comprises a latch 128 that operates to hold terminals 130/270 in place when the terminals are inserted into terminal blade receiver slots 150. In operation, each latch 128 will slide into each receiver slot 150 and will expand once terminal 130/270 is fully inserted into the receiver slot. In this manner, latch 128 interacts with a notch 48
25 in receiver slot 150 to hold the terminal in place (shown in Figure 4d). It is realized by one skilled in the art that many equivalent types of means exist to connect and hold the terminal in

place and that these embodiments are not limited to latch 128 for connecting the terminal to socket 100.

Referring to Figure 5b, alignment features 46 are located on each of two opposed terminal surfaces 44. In this embodiment, there are four alignment features 46 with two
5 alignment features 46 located on each of the surfaces 44 (Figure 4d shows all four alignment features). The alignment features 46 on each of the two opposed terminal surfaces 44 are located a sufficient distance apart from one another in order to provide for angular alignment and stability of terminal 270 once it is inserted into receiver slot 150 of the terminal accepting body 30. Further, alignment features 46 are located close to side wall 135. The close proximity of the
10 alignment features to the adjacent side wall 135 provides for rigidity between the alignment features. The alignment features can be located anywhere on the opposed terminal surfaces, as long as there is sufficient distance between the two alignment features to provide for angular alignment and stability of the terminal. However, it should be noted that the farther away from the side wall the alignment features are located, the more susceptible the terminal and alignment
15 features are to deformation because the increased distance from the side wall allows for more flexibility of the alignment features.

Figure 4b shows an exploded, bottom view of terminal accepting body 30 that utilizes terminal assemblies 270. As shown in Figure 4b, terminal blades 134 of terminals 270 are inserted into receiver slots 150 so that terminal lead ends 132 rest in terminal housing channels
20 140. The insertion force needed to insert the terminals into receiver slots 150 is minimized because the only contact between the terminals 270 and the interior walls 42 of receiver slot 150 is terminal alignment features 46. The alignment features 46 are bumps on terminal surfaces 44. As can be seen in Figures 4c and 5b, in this embodiment, the bumps each form a partial sphere on terminal surfaces 44. The partial sphere structure of alignment features 46 allow terminals
25 270 to be easily inserted into receiver slots 150. As terminals 270 are inserted, latch 128 will lock the terminals in place so that cover plate 136 will substantially cover receiver slot 150 and

prevent any sealing material from entering into the bulb accepting body 20 through receiver slot 150.

Figure 4c shows a bottom view of terminal accepting body 30 with terminals 270 inserted into receiver slots 150 and terminal housing channels 140. As shown in Figure 4c, cover plate 136 substantially covers receiver slot 150 and terminal lead ends 132 are located in terminal housing channels 140. Figure 4d shows a cross-sectional view of the bulb socket 100 along line E-E of Figure 4c. As shown in Figure 4d, terminal blade 134 is located within receiver slot 150 which extends into bulb accepting body 20. The tops of the terminal blade prongs 137 are located near terminal protecting pieces 52 that help protect the tops of the terminal blade prongs from damage during insertion of the bulb 10 into bulb accepting body 20. Further, latch 128 interacts with a notch 48 located in receiver slot 150 in order to lock the terminal 270 into place. Terminal alignment features 46 contact the interior walls 42 of receiver slot 150. In this embodiment, the alignment features are partial spheres and make only minimal point contact when touching the adjacent interior walls 42 of receiver slot 150. The location of each alignment feature 46 relative to the other alignment features is easier to control than it is to control the location of one entire opposed terminal surface 44 relative to the other opposed terminal surface 44. This allows there to be a minimal amount of clearance between terminal 270 and interior walls 42. In this manner, one can ensure that terminal 270 is properly aligned and stabilized to ensure that a proper connection between the terminal and bulb 10 is maintained at all times.

Figure 4d shows terminal 270 with four alignment features 46. Any number of alignment features can be utilized to stabilize and properly align terminals 270 in bulb socket 100. However, if only one alignment feature is used on each opposed terminal surface, the terminal will not be properly stabilized because the single alignment feature on each opposed terminal surface will act as a pivot point and cause the terminal to rock back and forth within the receiver slot. Therefore, at least three alignment features 46 should be positioned on opposed terminal surfaces 44 with at least one alignment feature positioned on one of the opposed terminal surfaces and at least two alignment features located on the other opposed terminal surface. The

use of at least three alignment features will prevent the terminal from rocking back and forth by providing a non-pivoting support. While the terminal alignment features 46 are partial spheres in this embodiment, terminal features can be of any shape and depth on the opposed terminal surfaces. The best shapes and proportions will be the ones that are easily incorporated into the design of the terminal via their tooling during manufacturing. The structure of the alignment features and the simplicity of adding them to the terminal provides for a cost effective, simply manufactured and easily assembled bulb socket assembly.

Referring to Figures 4a-5b, in order to electrically connect terminals 130/270 to lamp bulb 10, bulb connecting blade 134 is inserted into slots 150 in the posterior of lamp bulb socket 100, so that terminal connecting piece 135 latches terminal 130/270 into place. Once connecting blades 134 are inserted, terminal lead ends 132 will rest in terminal housing channels 140. In this manner, terminal lead ends 132 are aligned with harness wire retention slots 40 and are positioned side-by-side to one another in terminal accepting body 30 of lamp socket 100. During the assembly process, harness wires 160 (shown in Figure 17) are attached to terminal lead ends 132 by a method well known in the art, such as, the crimp method already described. Wires 160 are then threaded through and exit socket 100 through wire retention slots 40. Harness wires 160 are then sealed to terminal lead ends 132 and terminal accepting body 30 of socket 100 by the use of a direct potting method.

Direct potting involves the use of a sealing material with adhesive properties to secure the connection of harness wires 160 to terminals 130/270. The sealing material is poured around the connection of wires 160 to terminals 130/270, substantially covering the lead end 132 of the terminals 130/270. In a preferred embodiment, the sealing material fills the terminal accepting body 30 to the rim 31. Cover plate 136 covers receiving slot 150, which forms a passage between the terminal accepting body portion and bulb accepting body portion, and prevents the sealing material from leaking through slots 150 into the interior of bulb accepting body 20 of socket 100. Although small holes exist between terminals 130/270 and slots 150, the sealing material is sufficiently viscous and hardens fast enough to prevent significant amounts of the

sealing material from flowing into the bulb accepting body 20 of socket 100. Any type of sealing material can be used in sealing wires 160 to terminal lead ends 132 of terminals 130/270, but it is preferred that quick curing sealing materials, such as a polyurethane or a low pressure mold nylon, be used to allow for quick manufacturing of socket 100. In addition to providing a secure connection, direct potting creates an environmental seal around the connection and in this manner, eliminates any leak path between wires 160 and socket 100. Direct potting also eliminates the need for separate seals to connect terminals 130/270 to harness wires 160. In this manner, direct potting reduces the number of parts needed to assemble socket 100, reduces manufacturing cost, and reduces the amount of space needed to house the socket.

Once the sealing material hardens, harness wires 160 are sealed to terminals 130/270 and lamp bulb socket 100. Harness wires 160 are sealed to and exit wire retention slots 40 at about a ninety degree angle from insertion axis 190 (shown in Figure 1). In this position, socket 100 can be right angle loaded into socket recess 210. Alternatively, after wires 160 are threaded through retention slots 40 and sealed to terminals 130/270 and socket 100, the wires can be bent approximately ninety degree so that the harness wires exit the socket substantially parallel to insertion axis 190. In this position, socket 100 can be axially loaded into socket recess 210. In an embodiment without retention slots 40, harness wires 160 are sealed to and exit socket 100 substantially parallel to insertion axis 190. In this position, socket 100 can be axially loaded into socket recess 210. Alternatively, after wires 160 are sealed to and exit socket 100, the wires can be bent approximately ninety degrees so that the harness wires exit the socket substantially perpendicular to insertion axis 190. In this position, socket 100 can be right angle loaded into socket recess 210.

As shown in Figure 6a, the W-2 embodiment of lamp bulb socket 100 further comprises a bulb stabilizing feature 170. Figure 6a shows a top perspective view of bulb accepting body 20 of lamp bulb socket 100 with bulb 10 removed. Figure 7 shows a top view of bulb accepting body 20 in relation to socket 100. Figure 8 shows a cross-sectional view along line B-B of Figure 7 of bulb accepting body 20 and bulb stabilizing feature 170. Stabilizing feature 170

works in conjunction with terminals 130/270 (not pictured in Figure 6a – Figure 8) to minimize bulb wobbling, to provide bulb retention, and to provide electrical contact between the terminals and bulb 10. Referring to Figure 6a, bulb stabilizing feature 170 comprises angular ribs 180 which are molded to form four opposing edges: edge A 230, edge B 240, edge X 250, and edge Y 260. Diagonally opposed edge A 230 and edge B 240 define a first distance 580 in relation to a centerline 600, and diagonally opposed edge X 250 and edge Y 260 define a second distance 590 in relation to the centerline. First distance 580 equals the perpendicular distance from edge A 230 to centerline 600 plus the perpendicular distance from edge B 240 to centerline 600. Second distance 590 equals the perpendicular distance from edge X 250 to centerline 600 plus the perpendicular distance from Y 260 to centerline 600. The second distance 590 is greater than the first distance 580. In this embodiment, bulb flange channels 581 are provided on opposite sides of the angular ribs 180. Stabilizing feature 170 allows socket 100 to accept various bulb types of various sizes.

Figure 6b shows a front view and Figure 6c shows a side view of bulb 10 and bulb base 510. Bulb 10 comprises base 510 that includes cylindrical portion 550, flange portions 570, and bulb leads 560. Bulb leads 560 electrically connect to filament 561. Bulb 10 is inserted into lamp bulb socket 100 by first contacting the sides of flange portion 570 of the bulb base 510 with edge A 230 and edge B 240 (see Figure 6a). When flange portion 570 of bulb base 510 has a thickness greater than first distance 580 and is inserted into socket 100, the flange portion will contact edge A 230 and edge B 240 and force the bulb base to rotate about bulb insertion axis 190. Rotation of bulb 10 forces flange portions 570 against the spring tension of terminals 130/270, which are inserted into the flange channels 581. When bulb base 510 is inserted into socket 100, flange bulb base portions 570 will be kept in place by lamp bulb connecting blades 134 of terminals 130/270 and bring bulb leads 560 into electrical contact with terminals 130/270. This creates a tight grip on bulb base 510 and secures bulb 10 in place. In this manner, bulb stabilizing feature 170 creates a tight grip on bulb base 510, secures bulb 10 in place and prevents the bulb from wobbling.

In Figure 9, the W-3 embodiment of the subject invention is shown fully assembled comprising a bulb 650 and a lamp bulb socket 300. Bulb socket 300 comprises a bulb accepting body 310 connected to a terminal accepting body 320, a plurality of wire retention slots 40, three lugs 50 (only one pictured) molded onto the side of bulb accepting body 310, exterior alignment features 330, a seal gasket 70, and a seal flange 80. While the W-3 embodiment comprises three lugs 50, it will be appreciated by one skilled in the art that no lugs, a single lug or any number of a plurality of lugs can be used. In this embodiment, lugs 50 comprising stop feature 60 and lock feature 90, seal gasket 70, seal flange 80, rim 31, and harness wire retention slots 40 perform the same function as described in the W-2 embodiment. Accordingly, the W-3 embodiment of the subject invention can be loaded into socket recess 210 (shown in Figure 3) in the same manner as the W-2 embodiment.

Further, lamp bulb socket 300 may optionally comprise socket insertion wings 340. Socket insertion wings 340 provide an operator with a part of socket 300 to grasp and use to insert lamp socket 300 into lamp housing 200. This provides for easier installation and prevents damage to socket 300 and bulb 650 during the installation process. While the exemplary embodiment comprises two insertion wings 340, any number of insertion wings may optionally be used.

Figure 10 displays a bottom view of terminal accepting body 320 of lamp bulb socket 300. In the W-3 embodiment, lamp bulb socket 300 further comprises two major/minor terminals 350 with a major/minor terminal lead end 352 and ground terminal 360 with a ground terminal lead end 362. Figure 11 displays a cross-sectional view along line C-C of Figure 9 of terminal accepting body 320. As shown in Figure 11, lamp bulb socket 300 further comprises two major/minor receiver slots 370 and a ground terminal receiver slot 380 for receiving two major/minor terminals 350 and ground terminal 360 respectively (shown in Figures 12 and 13). As shown in Figure 10, an assembled socket 300 has major/minor terminal lead ends 352 and ground terminal lead end 362 protruding out of the posterior of the lamp socket. While the W-3

embodiment comprises two major/minor terminals 350, one or two major/minor terminals 350 may be used.

Referring to Figure 12, major/minor terminals 350 comprise a one-piece, axial terminal assembly that comprises major/minor terminal lead end 352, a lamp bulb connecting blade 354, and a cover plate 356. Terminal lead end 352 comprises a wire connecting piece 358 and a wire cradle 359. Terminal lead end 352 electrically connects major/minor terminal 350 to harness wires 160 in the same manner as terminal lead ends 132 of the W-2 embodiment connect to harness wires 160. It is appreciated by those of ordinary skill in the art that major/minor terminal lead ends 352 can comprise either a single crimp terminal lead end or a double crimp terminal lead end. Further, while terminals 350 comprise a one-piece major/minor terminal design, one skilled in the art realizes that terminals 350 can comprise a two-piece major/minor terminal design.

Cover plate 356 is located below connecting blade 354 so that when connecting blade 354 is axially inserted into major/minor terminal receiver slot 370, the cover plate will cover the entire opening of receiver slot 370. It will be appreciated by one skilled in the art that major/minor terminal 350 may comprise of many equivalent types of lamp bulb connecting blades to connect major/minor terminals to bulb 650 (shown in Figure 9) and is not limited to blade 354 pictured in Figure 12. Additionally, major/minor terminal 350 can further comprise terminal connecting pieces 355. When terminal 350 is inserted into major/minor receiver slots 370, connecting pieces 355 will slide into the slots and expand once the terminal is fully inserted. In this manner, connecting pieces 355 interact with the floor of the bulb accepting body 310 of socket 300 to hold major/minor terminals 350 in place.

Referring to Figure 13, ground terminal 360 comprises ground terminal lead end 362, a ground lamp bulb connecting blade 364 and a ground terminal cover plate 366. Ground terminal lead end 362 comprises a wire connecting piece 368 and a wire cradle 369. Terminal lead end 362 electrically connects ground terminal 360 to harness wires 160 in the same manner as terminal lead ends 132 of the W-2 embodiment connect to harness wires 160. It is appreciated

by those of ordinary skill in the art that ground terminal lead end 362 can comprise either a single crimp terminal lead end or a double crimp terminal lead end. Further, while terminal 360 comprises a one-piece ground terminal design, one skilled in the art realizes that terminal 360 can comprise a two-piece ground terminal design.

5 Cover plate 366 is located below connecting blade 364 so that when the connecting blade is inserted into ground terminal receiver slot 380, the cover plate will substantially cover the opening of ground terminal receiver slot 380. It will be appreciated by one skilled in the art that ground terminal 360 may comprise many equivalent types of lamp bulb connecting blades to electrically connect ground terminal 360 to bulb 650 and is not limited to blade 364 pictured in
10 Figure 13. Additionally, ground terminal 360 can further comprise terminal connecting piece 365. When terminal 360 is inserted into ground terminal receiver slots 380, connecting piece 365 will slide into the slot and expand once the ground terminal is fully inserted. In this manner, connecting piece 365 interacts with the floor of bulb accepting body 310 of socket 300 to hold ground terminal 360 in place.

15 Referring back to Figures 10-12, in order to electrically connect two major/minor terminals 350 and ground terminal 360 to a lamp bulb, major/minor bulb connecting blades 354 and ground bulb connecting blade 364 are inserted into major/minor receiver slots 370 and ground receiver slot 380 respectively. During the assembly process, harness wires 160 (shown in Figure 17) are attached to major/minor terminal lead ends 352 and to ground terminal lead end
20 362 by a method well known in the art, such as the crimp method. Harness wires 160 are threaded through harness wire retention slots 40. Wires 160 are then sealed to major/minor terminal lead ends 352, ground terminal lead end 362 and terminal accepting body 320 by the use of the direct potting method already described. After harness wires 160 are sealed, the wires are in a position that allows socket 100 to be right angle loaded into socket recess 210.
25 Alternatively, after wires 160 are threaded through retention slots 40 and sealed to major/minor terminals 350, ground terminal 360, and socket 300, the wires can be bent approximately ninety

degrees so that the harness wires exit the socket substantially parallel to insertion axis 190. In this position, socket 300 can be axially loaded into socket recess 210.

As shown in Figures 14 and 15a, lamp bulb socket 300 further comprises exterior alignment features 330 that include side rail alignment channels 410 and interior alignment features that include retention arms 425, centrally located angular ribs 420 and an axial channel 430. As shown in Figure 15a, axial channel 430 is located between angular ribs 420 and runs the entire length of the angular ribs. Figure 14 displays a top view of bulb accepting body 310 of socket 300 and exterior alignment features 330 that comprise side rail alignment channels 410. In the present embodiment, side rail alignment channels 410 are notches made on opposing sides of the interior of the lamp bulb socket wall. Side rail alignment channels 410 run from the top of lamp bulb socket 300 down to minor/major terminals 350 and ground terminal 360, when the terminals are inserted into slots 370 and 380. The height of side rail alignment channels 410 is optimally set in relation to the height of terminals 350 to provide for initial bulb 650 (shown in Figure 9) entry alignment. Side rail channels 410 include angular seats 440. In this manner, side rail alignment channels 410 line up the base of bulb 650 with major/minor terminals 350 and ground terminal 360 and limit the rotational and lateral movement of the lamp bulb within the walls of lamp bulb socket 300.

Figure 15a displays a cross-sectional view of the interior of the bulb accepting body along line D-D of Figure 14. As shown in Figure 15a, the interior of bulb accepting body further comprises centrally located angular ribs 420 that extend above the major/minor terminals 350 and that form axial channel 430. While the W-3 embodiment comprises two centrally located angular ribs 420 and one axial channel 430, any number of angular ribs and axial channels may be used.

Figure 15b shows a side view and Figure 15c shows a front view of bulb 650. Bulb 650 comprises base 660 that includes bulb collar 652, key tabs 670, flange portion 680, and bulb leads 690. Bulb leads 690 electrically connect to filament 691. Referring back to Figure 15a, when bulb 650 is inserted into bulb accepting body 310, key tabs 670 of the bulb (see Figure

15c) first slide down side rail alignment channels 410 until they contact angular seats 440. As bulb 650 continues into bulb accepting body, flange portion 680 contacts the tops of angular ribs 420 prior to contacting major/minor terminals 350 and ground terminal 360 (not pictured). Angular ribs 420 direct flange portion 680 toward and into axial channel 430. Flange portion 680 then enters axial channel 430 which is designed and dimensioned to hold the flange portion. In this manner, angular ribs 420 and axial channel 430 further guide base 660 of bulb 650 into proper alignment with major/minor terminals 350 and ground terminal 360 and ensure clearance between the lamp bulb and the major/minor terminals and ground terminal during insertion. By ensuring clearance between bulb 650 and major/minor terminals 350 and ground terminal 360 during insertion, angular ribs 420 and axial channel 430 protect the tops of the terminals from damage and ensure that the bulb does not hit the tops of the terminals and break during insertion. Bulb 650 is inserted until each bulb lead 690 comes into contact with major/minor terminals 350 and ground terminal 360 respectively and the tops of retention arms 425 clip onto bulb collar 652.

These embodiments of the bulb socket allow for a relatively new wiring configuration in automotive lighting. Referring to Figure 16, the normal method of electrically connecting a plurality of lamp bulb sockets 450 utilizes two individual harness wires 460 connected to each socket. Harness wires 460 are then spliced together to form an electrical connection 470. As shown in Figure 17, these embodiments allow for a plurality of sockets 500 to be "daisy chained" together by harness wires 160. Daisy chaining is possible because the direct potting method allows for a lamp socket to make an environmental seal around a terminal connected to multiple wires. In this configuration, wires 160 travel directly from one lamp bulb socket 500 to another. This method reduces the number of splices and wire seals that need to be employed resulting in decreased manufacturing costs.

While particular embodiments have been described in considerable detail herein, such is offered by way of non-limiting examples of the invention as many other versions are possible. It is anticipated that a variety of other modifications and changes will be apparent to those having

ordinary skill in the art and that such modifications and changes are intended to be encompassed within the spirit and scope of the appended claims.